U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-254 636

CLEAN AIR AND YOUR CAR

ENVIRONMENTAL PROTECTION AGENCY

MARCH 1974

190048

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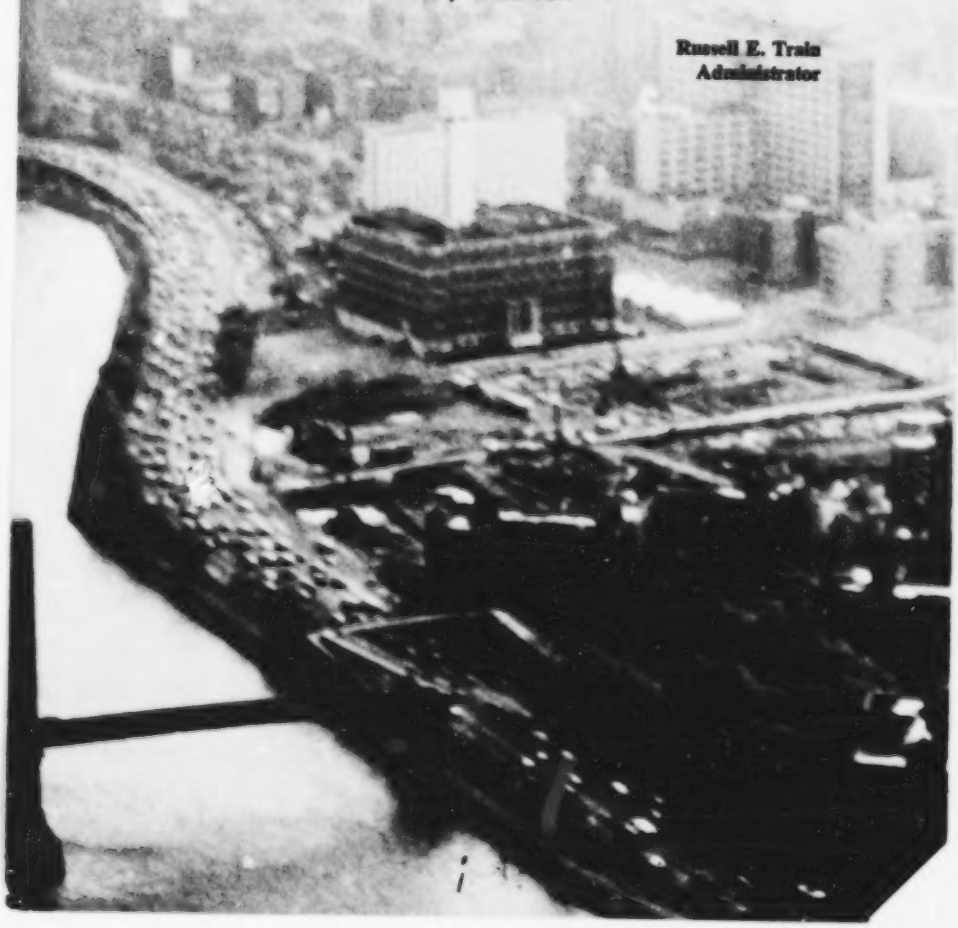
PB 254 636

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

"It is no accident that both the energy crisis and the clean air effort have combined to place increasing restrictions upon the private, single-passenger automobile, which has in so many respects served as the vehicle that has driven our metropolitan areas apart. Americans are beginning to wake up to the fact that the congestion in our city streets and in our lungs stems from very much the same source: our excessive, even exclusive, reliance upon the automobile and upon patterns of growth and development that leave us no choice but to depend upon the automobile. The plain fact is that we cannot expect to achieve air fit to breathe or cities fit to live in until we build both cleaner engines and smaller cars and mass transit systems that offer a real alternative to the private car."

Russell E. Train
Administrator



CLEAN AIR AND YOUR CAR

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MARCH 1974

U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

The American Dream Machine—the automobile—once meant convenience, easy transportation and pleasurable outings. But that dream is rapidly becoming a nightmare—a nightmare created by the very vehicle that promised and gave us so much. The growing army of automobiles has diminished the quality of our lives by polluting our air and our environment. The advantages are being eroded by the disadvantages. Our air is not fit to breathe, traffic is jammed bumper to bumper, noise assaults us from the roadways. And now, gasoline shortages compound our problems.

Does it have to be this way?

We at the Environmental Protection Agency (EPA) think not. EPA has been assigned the responsibility of controlling pollution to restore a healthy environment for all of us. But it can only be done with everyone's cooperation and understanding.

This booklet discusses the automobile, what it has done to the environment, what is being done to deal with auto pollution, and how all this affects you. Hopefully, after you have read through these pages, you will join your fellow citizens in responding "No, it doesn't have to be this way."

And with your cooperation, it won't be.

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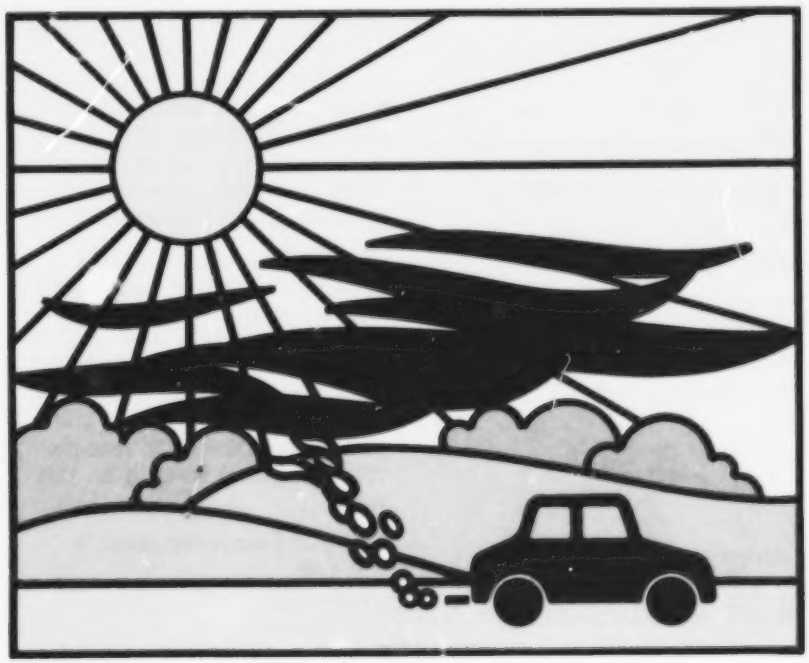
How It All Began

It was something less than a good day in 1946 when the Los Angeles Times reported:

> "Like a dirty gray blanket flung across the city, a dense eye-stinging layer of smog dimmed the sun here yesterday. The fumes hung unmoving in the still air, rousing tears and sniffles in thousands of Angelenos."

The item erred in one important detail. What stung the eyes and roused the sniffles was not "smog"—a combination of smoke and fog—but something far more serious. It was properly identified four years later by a California scientist: It was a chemical reaction that, in the presence of still air and strong sunlight, converts hydrocarbons and nitrogen oxides (both emitted from car exhausts) into photochemical oxidants.

For the first time, a link was made between gasoline-powered engine exhausts and easily observed effects on public health and welfare. This discovery triggered new research into the effects of automobile emissions and set in motion actions that led to the development of strict standards to control pollution from motor vehicles.



What the research revealed

The photochemical oxidants were found to have effects other than stinging eyes and causing sniffles. There is evidence that people begin to suffer eye irritation when exposed for a short time to 0.10 parts per million of these substances in the air. Among athletes and children at play, even brief exposure can cause, as scientists put it, "impaired performance." Persons who suffer from asthma can experience more attacks when exposed to these substances. A recent study correlated the frequency of traffic accidents with oxidant levels that dull the senses, impair vision, and increase driver irritability.

Further, laboratory experiments with animals indicate similar health effects. After brief exposure to oxidants, mice are more susceptible to bacteria and their activity is decreased. Longer exposure produces structural changes in cell membranes and heart muscles. Other laboratory animals exposed to oxidants exhibited chronic bronchitis, emphysema, and reduced stability of the cells that protect the deep lung against infection. Hamsters exposed to oxidants for five hours showed evidence of a breakdown of white blood cells.

Nitrogen oxides

The health effects of nitrogen oxides appear to be concentrated in the respiratory system and result from long-term exposure. In studies of Chattanooga, Tenn., schoolchildren, for example, during exposure periods of three to six years, scientists found a sharp increase in acute respiratory illnesses directly attributable to nitrogen oxides.

The same studies disclosed significantly decreased lung function among children in the school group. And among children exposed to nitrogen oxides for two and three years, there was a significant increase in cases of bronchitis.

Hydrocarbons

At concentrations usually found in the outdoor air, hydrocarbons do not have any direct effects on humans or animals. But since they help to form photochemical oxidants, in combination, they have a definite effect on both people and animals.

Carbon monoxide

Auto exhausts also contain carbon monoxide which is poisonous. Relatively brief exposure to high levels of this chemical compound can cause disability. Longer exposure at high levels can cause death. But what about brief exposure to carbon monoxide, perhaps while driving or riding in a car during rush hour?

Carbon monoxide combines with the coloring matter (hemoglobin) of red blood cells to form another compound known as carboxyhemoglobin. This compound interferes with the life-sustaining transfer of oxygen from the lungs to body tissues and the return of carbon dioxide from the tissues to the lungs.

Scientists recently tested men with mild heart disease, after exposure to 90 minutes of Los Angeles rush-hour freeway traffic. The tests disclosed striking changes in their electrocardiogram and tolerance to exercise. The levels of carboxyhemoglobin in their blood was increased by 5 percent. People who are exposed for an hour or less to relatively

high levels of carbon monoxide, after heavy work, were found to have more than double the normal levels of carboxyhemoglobin found in a person at rest.

Carbon monoxide also affects the central nervous system. Tests of young automobile drivers—after exposure to carbon monoxide—show slower reaction times in response to braking signals.

Other effects

While the automobile has made it possible for the average American to enjoy a mobility unequalled in history, we may have allowed ourselves to become too dependent on our Dream Machine. We have reorganized our cities and our lives to take advantage of our new mobility. There is now one car on the road for almost every two people

in the United States. But in this world of "dream" convenience, one-quarter of our population is left outside the reach of auto travel—they are the old, the handicapped and the poor. More citizens are immobilized because other means of transportation have been neglected.

As a people mover, the automobile is highly inefficient. Statistics show over half of all auto trips are less than five miles long. Eighty-two percent of U.S. commuting is done by car and usually with just the driver inside. In rush-hour traffic with cars built for highway speeds, we creep along at 5 to 7 miles an hour. And to make matters worse the penalties of our poor driving habits are now compounded by the energy shortage.

petroleum and pollution

In addition to air pollutants emitted by the motor vehicle, the refinement, transportation and disposal of the petroleum products used in powering and maintaining motor vehicles produce secondary pollution effects that in a social accounting sense must be attributed to these machines. These secondary effects include the spillage of 7.5 million gallons of oil per year, the emission of 3.4 million tons of air pollutants from petroleum refineries annually, and the improper disposal of 600 million gallons of spent crankcase oil.

The energy problem

An energy shortage has resulted from our increasingly extravagant use of energy to transport ourselves and our goods. In 1970, cars, trucks and buses travelled a total of 1.1 trillion miles, consuming more than 90 billion gallons of petroleum products in the process. That is the equivalent of 6 million barrels of crude oil a day or more than 40 percent of all the petroleum products used in the United States in 1970.

In 1973, about three-quarters of all gasoline was consumed by the automobile, which, in commuting situations, carried an average of only 1.2 persons per vehicle. From an economic standpoint, such waste is indefensible especially in urban areas when buses are nearly three times more efficient per passenger mile than the private automobile.

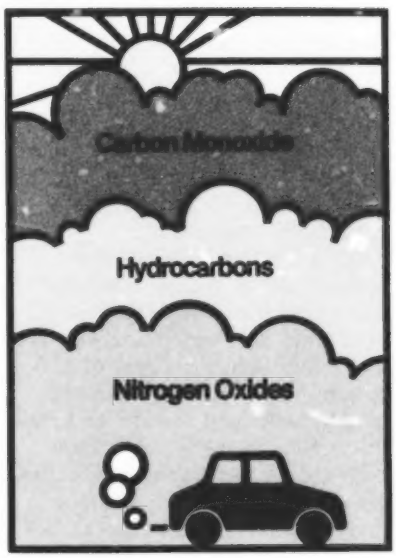
The energy shortage is likely to continue. The time has come when all of us must "rethink" our automobile and how we use it.

The Steps That Have Been Taken

With the recognition of the effects of automobile emissions on health and welfare, action was begun to control them. California was the first State to impose pollution controls on cars. In 1963, that State required the first simple emission controls on all new cars sold within its boundaries.

In 1966, California also set standards for emissions control of hydrocarbons and carbon monoxide for new cars sold in the State. The Federal Government adopted the California standards nationally starting with 1968 models, and began a program for the gradual tightening of auto emission controls. But the auto pollution problem grew faster than the control program. In 1970, gasoline-powered motor vehicles contributed 50 percent of all hydrocarbons, 90 percent of all carbon monoxide, and 30 percent of all nitrogen oxides emitted into the air in the United States. In some cities, the motor vehicle contribution to total air pollution was as much as 90 percent by volume.

To deal with the growing problem the Federal Government took two significant steps in 1970. First,

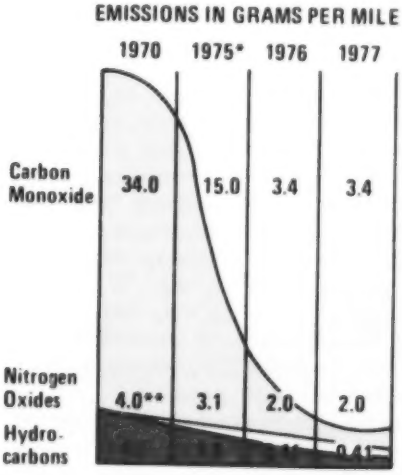


Congress passed the Clean Air Amendments, and second, the Environmental Protection Agency was created to centralize all Federal environmental protection programs. With a mandate to mount an integrated, coordinated attack on pollution, EPA's authorities are in implementing the laws passed by Congress. EPA's primary role in air pollution is to establish controls that will meet air quality requirements and to see that they are enforced.

The Clean Air Amendments called for strict standards for the three major air pollutants emitted by cars—

hydrocarbons, carbon monoxide and nitrogen oxides. EPA established strict requirements for cutting back auto emissions to meet these standards over the next three years (see chart below).

These sharp reductions in exhaust emissions were not arbitrarily decided upon. Careful studies were made of air pollution, its causes and solutions. The emissions standards arrived at are part of a comprehensive national program to bring air pollution down to levels necessary to safeguard human health and the environment.



* In California, which has particularly severe auto-emissions problems, 1975 model cars may emit no more than 0.9 grams of hydrocarbons per mile, 9 grams of carbon monoxide, and 2.0 grams of nitrogen oxides.
** 1971 level.

Applying the controls

The Federal Government does not tell car manufacturers how to reduce auto emissions. Under the Clean Air Amendments, EPA has established emissions standards for cars through model year 1975. Congress itself set the limits that must now be achieved with later models.

The ultimate choice of how to meet the standards has been left to the manufacturers. In other words, the Federal Government sets the standards; the automakers pick the technology to meet those standards, and before they are sold, the new cars are subject to certification by EPA to insure that they do meet the standards.

Before examining the ways chosen by auto manufacturers to control pollution, it is helpful to understand exactly where automobile pollutants come from. Without controls, gasoline-powered cars emit pollutants from the fuel tank, carburetor, crankcase, and engine exhaust. The exhaust alone is the primary source of nearly all the carbon monoxide and nitrogen oxide emissions and more than half of the hydrocarbons.

But it all begins under the hood. To get a better idea of the changes that have been and will be made in cars, see "A Look Under the Hood" (page 17).

Costs of emissions controls

What does this effort to clean up the automobile—to get air that's safe to breathe—really mean to you as a car owner and driver, and as a citizen?

We all benefit, of course, in improved health as emissions of auto pollutants are reduced. But cleaner air and a better environment will not come without some sacrifices in effort and in money from all of us. There are, and will continue to be, noticeable changes in your car's performance, in gasoline mileage and in the cost of a new car.

Very real changes are already being made in automobiles. For 1974 cars, air pollution limits are still not extremely stringent. But for 1975, '76 and '77 models, the Clean Air Amendments dictate tough levels.

What are some of the changes you can expect?

Performance. Some new cars are hard to start in cold weather, slow to warm up, and a bit more hesitant in operation. Some of these differences in performance stem from the devices and techniques chosen by manufacturers to comply with emission standards. Whether the problems will persist in later models is hard to say. What can be said is that manufacturers are still designing systems for lower emissions; at the same time, they are also aiming to retain optimum performance.

Gas Mileage. As for fuel economy, available figures indicate a fuel economy loss of about 10 percent for 1973 models when compared with pre-1968 models of the same weight without controls. That is a small increase when one considers the health benefits and compares the 10 percent fuel loss for controls to the 20 percent fuel penalty paid for air conditioning on a hot day in downtown traffic.

The main factor in determining gasoline mileage is the weight of a car. In city traffic, a 1974-model weighing 5,000 pounds gets about 9 miles to the gallon, while a car weighing 2,500 pounds gets 18.5 miles to the gallon.

There is evidence that the fuel economy problem can be overcome. A Japanese firm, the Honda Motor Co., announced in early 1973 that it had come up with an emission control system that met 1975 standards "without any sacrifice in fuel economy." The Japanese company also pointed out that when it had applied its system to two 1972 Chevrolet Vegas, the modified cars then met the 1975 standards—and that their gasoline consumption had actually improved from 17.2 miles per gallon to 18.6 miles per gallon.

Fuel Cost. You may see a slight increase–about one-quarter of one percent per gallon–in the cost of gasoline because of air pollution controls. (The energy shortage is expected to increase it much more.)

The controls call for a reduction of lead, commonly used in gasoline as an anti-knock additive. Lead is a health hazard. Too much in the human body can cause anemia, abdominal colic, and damage to the brain and nervous system. In many urban areas, motor vehicles are the major source of lead in the air. Thus, to protect public health, EPA has proposed reductions in the lead content of gasoline.

Lead and phosphorus, another fuel additive, can also ruin the devices that most car manufacturers plan to use to meet 1975 emission standards. EPA has therefore required oil companies to provide one grade of lead-free and phosphorus-free gasoline in time for use by 1975 model cars. The added costs that may result, should be somewhat offset because the cleaner gasoline should give longer life to sparkplugs and mufflers.

The Sticker Price. What about the cost of a new car with emission controls? A recent report of the National Academy of Sciences says emission controls added to new cars between 1968 and 1973 raised the sticker price $100.

The report estimates that emission-control hardware planned for 1974 models will add about $20 to the sticker price. And the new hardware needed by 1975 and 1976 models will add $138 and $134 respectively. When the costs of buying, driving, and maintaining a new car with a cleaner engine are computed for the useful life of the car, the total cost to the owner ranges from about 40¢ to $1 a week.

foreign-made vehicles

All motor vehicles–cars, motor homes, campers and trucks–manufactured abroad for sale in the United States must meet EPA auto emission standards. Manufacturers have been given the same compliance schedules as domestic producers.

Any individual purchasing a car overseas for importation into the United States is responsible for seeing that his vehicle complies with emission standards. A nonconforming vehicle will not be permitted to enter. For more advice and detailed information on this problem write: EPA, (A–107) Washington, D. C. 20460, for a leaflet on importing vehicles.

Some Words of Warning. If your new car is hard to start or slow to warm up, if it stumbles or surges or uses too much fuel, don't try to correct the problem by inactivating the emission control system. Why not? Because there is a strong likelihood that tampering with the system will decrease performance and fuel economy and may cause engine damage.

Any change in any part of the complete system will affect the operation of some other part or parts. Such changes may cost you money by damaging your engine. They are also likely to result in more pollutants being emitted into the air we breathe. And there is still another reason.

To further protect you and improve the quality of the air, the Clean Air Amendments make it illegal for anyone, prior to the sale of a car, as well as the manufacturer or dealer after the sale is completed, to remove or "render inoperative" the emission control system. A fine of up to $10,000 is provided for each violation.

If you believe a manufacturer or a dealer has tampered with the emission control system on your car, you can obtain help from EPA. Get in touch with the EPA regional office nearest you (see page 23), or contact the EPA Division of Mobile Source Enforcement (EG-333), Washington, D.C. 20460.

One last word on tampering: Under the Clean Air Amendments, car manufacturers must provide a warranty of five years or 50,000 miles on the emission control systems of their cars. Tampering with the system, so that the car fails to meet emission standards, can void the warranty. Moreover, many States have laws against tampering that apply to used cars where the Federal laws do not.

The Clean Air Amendments also provide for recall of any cars which do not meet emission standards through their useful life. If EPA in its emission testing program, determines that a class or category of cars does not conform to emission standards, the manufacturer must recall those vehicles and correct the nonconformity. If you have an emission-related defect or if you suspect the emission control system on your car is faulty, contact EPA's Division of Mobile Source Enforcement.

Is it worth the effort?

At this point, you might be wondering if the emission control standards imposed on autos are worth the effort. Have they indeed brought, and will they continue to bring cleaner air? Consider these findings and projections from EPA studies:

In 1967, the 88 million motor vehicles in use in the United States emitted 20 million tons of hydrocarbons and 118 million tons of carbon monoxide.

If hydrocarbons and carbon monoxide emissions had remained

bargain

Air pollution causes an estimated $16 billion a year in damage to health, crops, materials and property values, according to the best available evidence. If air pollution were not controlled, the damage it inflicts would rise to a projected $25 billion a year by 1977, according to EPA studies.

In contrast, the cost of controlling air pollution—including emission controls on motor vehicles—is estimated at $10.7 billion a year for the ten-year period of 1971-1980.

uncontrolled, the 97 million vehicles in use in 1972 would have produced 24 million tons of hydrocarbons and 142 million tons of carbon monoxide. With controls, motor vehicle emissions in 1972 were reduced to an estimated 14.6 million tons of hydrocarbons and 93 million tons of carbon monoxide.

The auto emissions pollution problem is especially acute in certain urban areas, requiring special action. EPA has initiated transportation control strategies to deal with the complexities involved.

Transportation control strategies

"Transportation controls" is a term used by EPA to identify various complex changes that must be made in ways that people move from place to place. These changes are needed to achieve healthful air in many urban areas where the direct control of emissions from power plants, factories, apartment houses, and other stationary sources of pollution, coupled with pollution control of new cars, still will not bring the required degree of improvement in air quality. Other mobile sources of pollution must also be controlled.

In general, transportation controls cover such measures as

steps to improve the flow of traffic, improvements in mass transit, bans on parking, steps to encourage car pooling and measures to reduce the total number of vehicle miles traveled. Steps will be taken to encourage a change in driving habits—particularly those that lead to car pooling and the increased use of mass transit.

Also part of transportation controls are such less stringent measures as requiring the installation of improved emission control devices on pre-1975 cars, and State inspections of privately owned cars to insure that they meet the various emission standards.

The various measures that are to be used were selected only after their effectiveness was weighed against the effectiveness of other possible methods of reducing pollution, and after full consideration by State and local authorities and the public of all possible social and economic dislocations that might be associated with such measures.

What will be required is a fundamental change in the relationship of the American citizen to the private automobile. Such a change must occur if he is to preserve his health and his environment. Besides these two fundamental reasons for change, there are other tangible reasons as well.

A basic reliance on mass transit, coupled with changes that will reduce congestion in our urban centers, will make our cities more liveable. Reducing vehicle use will conserve energy. Inspection and maintenance programs will keep our cars running more efficiently.

One advantage offered by mass transit is too often overlooked—it would permit the millions of Americans cut off from our usual mode of living because they lack a car, to rejoin the mainstream of American life.

Another major benefit of mass transit relates to improved land use. Half the occupied land in some of our central cities is paved for roads and parking space. There is nearly one mile of road for every square mile of land in the United States, and some 130,000 more acres annually are lost to new highways and airports. This has created increased pressure for the use of remaining land, particularly the open spaces left in cities and suburbs. Expansion of mass transit could mean that available open spaces would no longer have to be pressed into service as roads and parking facilities.

To achieve clean air and a better quality of life, automobile emissions must be reduced substantially, effective transportation controls must be applied when required, and improved and expanded mass transit systems must be developed in many urban and suburban areas. Each of these measures is within our reach.

Urban areas requiring transportation control plans

Birmingham, Ala.
Mobile, Ala.
Phoenix-Tucson, Ariz.
Los Angeles, Calif.
San Francisco, Calif.
San Diego, Calif.
Fresno, Calif.
Sacramento, Calif.
Denver, Colo.
Metropolitan Washington, D.C.
Chicago, Ill.
Indianapolis, Ind.
Baton Rouge, La.
Baltimore, Md.
Boston, Mass.
Springfield, Mass.
Minneapolis-St. Paul, Minn.
Metropolitan Kansas City, Mo.
Metropolitan New York, N.Y.
Rochester, N.Y.
Syracuse, N.Y.
Cincinnati, O.
Dayton, O.
Portland, Ore.
Pittsburgh, Pa.
Metropolitan Philadelphia, Pa.
Houston-Galveston, Texas
Dallas-Ft. Worth, Texas
San Antonio, Texas
Beaumont, Texas
Austin-Waco, Texas
El Paso, Texas
Corpus Christi-Victoria, Texas
Salt Lake City, Utah
Seattle, Wash.
Spokane, Wash.

You may get information on the transportation plans proposed for these cities by contacting your area EPA regional office (see page 23).

What Steps Can You Take?

Without a doubt, the automobile will remain an important part of the American lifestyle. It will continue to have a dominant role in the far suburbs, on the farm, between cities over short distances, and as an alternate mode of transportation everywhere.

But the time has come when we must be more selective. We must restrict the automobile's use, and supplement it, if we are to obtain the most efficient service from it—and if we are to have the clean air necessary for life.

Manufacturers are moving ahead on the technological front to find clean systems that will meet the environmental challenge.

But there is much you—the consumer—can do.

For one thing, you can provide incentives to manufacturers to build models that exhibit the best fuel economy, performance and driveability by buying that car. An EPA fuel economy labeling program has been implemented to help you pick a new car with good fuel economy.

Fuel economy labeling

To put the cost of emission controls into proper perspective, EPA studied the fuel penalty resulting from such consumer choices as air conditioning, automatic transmissions and big heavy cars. The results show:

- An air conditioner (found in more than 60 percent of new cars) reduces gas mileage by 9 to 20 percent, depending on driving and weather conditions.
- An automatic transmission reduces fuel economy 2-15 percent.
- Vehicle weight is the single most important item affecting fuel economy. A 5,000-pound car takes twice as much gas to run as a 2,500-pound car and gets half as much mileage.

A recent EPA study of automotive fuel consumption shows that emission controls do affect fuel economy. Fuel economy loss for 1973 model year vehicles over those with no emission controls ranges from 18 percent for heavier cars to actual improvements of 3 percent in fuel economy for lighter cars, and data from a major car maker indicates it should remain unchanged in 1975 cars. Using these figures, the average driver's fuel bill will increase less than $25 a year due to emission controls. EPA estimates the increased fuel consumption for 1977 model cars to be in the range of 10 to 12 percent.

Significantly, studies also show that the difference in fuel economy between light and heavy cars has been increasing as emission controls have become more stringent. The fuel economy of lighter cars is not really affected by controls. This may be because smaller cars are designed from the beginning to achieve better fuel economy by employing smaller engines, manual transmissions and fewer accessories.

Switching from large to small cars then would mean savings in energy and consumer dollars and could also far outweigh savings that might be achieved by cutting down on optional equipment.

Under EPA's voluntary labeling program, car manufacturers have been asked, beginning with 1974 models, to place a sticker on each automobile showing vehicle size, vehicle weight, average miles per gallon and average annual fuel cost.

To supplement the sticker information, the dealer showrooms of participating manufacturers will offer additional data approved by EPA and a special EPA leaflet explaining the program and offering still more facts. For a copy, write: "Miles-Per-Gallon," Office of Public Affairs, (A–107) EPA, Washington, D. C. 20460.

Other actions you can take

Driving and maintenance habits are also major determinants of fuel economy. Consider the following:

- Trip length has a significant effect on fuel economy. Short trips result in poor fuel economy because the engine is less efficient while it is warming up.
- The driver who habitually accelerates away from a stop, using maximum power, uses up to 15 percent more fuel than a driver who uses moderate acceleration.
- A tuned car will average 6 percent better fuel economy than an untuned car.
- Use of radial tires results in approximately a 3 percent improvement in fuel economy over conventional non-belted tires.
- The best fuel economy occurs at a steady speed of between 30 and 40 miles per hour.
- At a cruise speed of 70 mph, the fuel economy is significantly worse than at 50 or 60. Cruising at 60 instead of 70 mph improves economy by about 15 percent. And at 50 mph, the savings in fuel rises to 25 percent.

These are ways you can economize on fuel, and there are others.

For more technical information, write for: Automotive Fuel Economy Report, Office of Public Affairs, (A–107) EPA, Washington, D. C. 20460.

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A Look Under the Hood

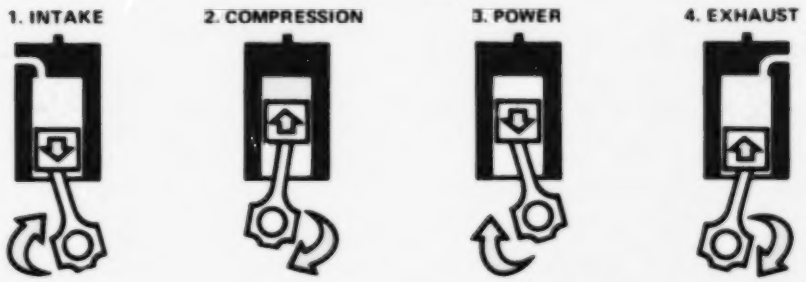
The poisonous gases emitted by automobile exhausts are the waste products of combustion. In a typical automobile, gasoline (a hydrocarbon fuel) is fed from a tank to a carburetor where it is mixed with air. This mixture is then drawn into the cylinder, (1) where it is compressed (2) and ignited by the spark plug (3). The resulting explosion forces the piston down the cylinder.

This is the power stroke, which is transmitted through various shafts and gears to drive the car.

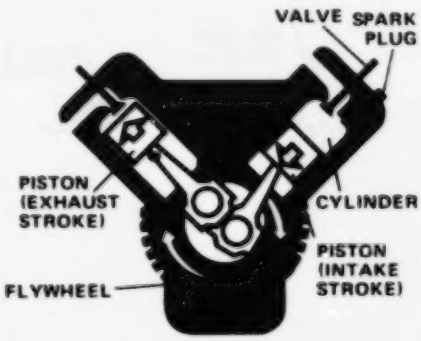
When the piston is at the bottom of its downstroke, the cylinder is full of hot gases—unburned hydrocarbons, carbon monoxide, nitrogen oxides, and carbon dioxide—water, particles of lead, and other compounds.

Then the piston rises to expel the remaining gases (4) through an exhaust valve, and the cycle is repeated. This action is repeated in each of the engine's cylinders.

V-TYPE INTERNAL COMBUSTION ENGINE
Four-Stroke Cycle



Front cutaway of V-engine



Illustrations in this section are highly simplified schematics to show only pertinent functions.

We are concerned with controlling the harmful emissions that leave the engine through the exhaust valve. Other potential sources of harmful automobile emissions—from the fuel tank or from exhaust gases that seep into the engine crankcase from around shafts and gears—have been virtually eliminated by relatively simple controls installed under Government regulations.

Enormous progress has been made in creating a new ability to

control automobile air pollution. For example, in recent model cars sold in California and elsewhere, a new system was developed to recirculate exhaust gases to mix with fuel and air in the carburetor. This lowered the heat of the power-stroke explosion and reduced nitrogen oxides emissions. The system was required first in California because of that State's serious problem with photochemical oxidants, to which nitrogen oxides contributed.

The Catalytic Converter

To meet the more stringent auto exhaust standards that will go into effect over the next four years, most U.S. automakers have elected to neutralize pollutants by trapping and treating them after they leave the combusion chamber.

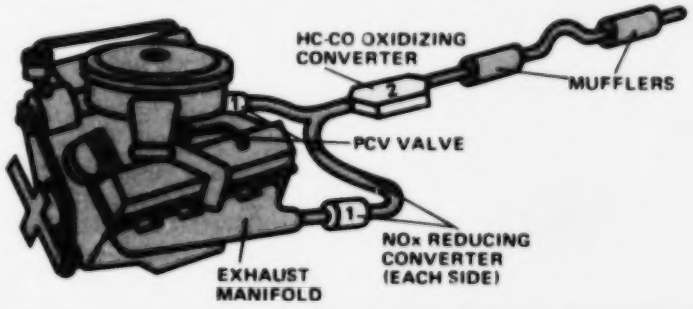
To do this, automakers plan to rely on a catalytic converter system. In this system, the pollutants pass through a stainless steel container about the size of a quart bottle. Here the hydrocarbons are converted into harmless carbon dioxide and water. Carbon monoxide is converted into carbon dioxide. The exhaust, practically free of harmful pollutants, is expelled through a conventional muffler. To keep these catalysts working will require the use of lead-free gas.

EPA has accepted the use of this system, allowing manufacturers time as authorized by Congress to perfect it to meet the standards for hydrocarbons and carbon monoxide.

New approaches

While the single catalyst system is expected to meet hydrocarbon and carbon monoxide standards, a dual-catalyst emission control system has been developed to reduce nitrogen oxides. This adds a second catalyst which breaks down nitrogen oxides into nitrogen and oxygen. These partially cleaned gases then pass into the second catalyst and continue as above.

THE DUAL- CATALYTIC CONVERTER



The dual-catalyst system ultimately may not be required since EPA has recommended that nitrogen oxide standards so stringent as to need such a system be suspended until 1991.

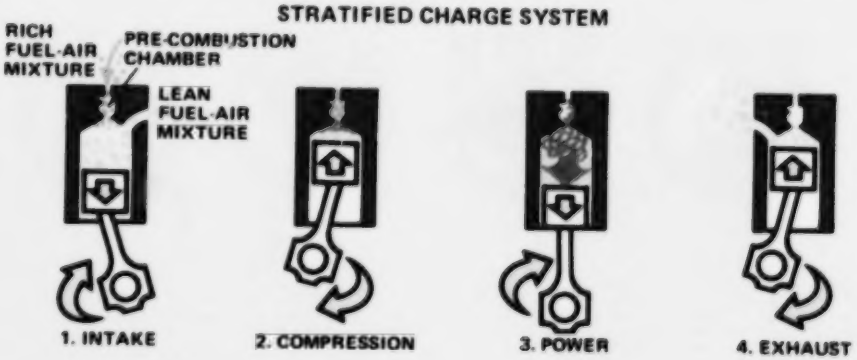
To meet the more stringent hydrocarbon and carbon monoxide standards scheduled, several manufacturers are developing other types of engines or other modifications of the internal combustion engine. Here is some of the progress that has been reported.

The stratified charge engine—One of the modifications, known as a three-valve, stratified charge, carbureted engine, is being developed by a Japanese firm. Three vehicles using this engine have completed EPA's 50,000-mile durability tests and have met the 1975 standards. In a stratified charge engine, the central idea is to supply a rich mixture near the point of ignition inside the cylinder. But the rest of the mixture is kept lean. This helps to reduce the mass of nitrogen oxides formed, allowing better burning of hydrocarbons and carbon monoxide.

The Japanese firm's engine has a conventional block, pistons and spark plugs. Only the cylinder head and intake and exhaust manifolds are modified, and two carburetors are used instead of one.

The essential part of this system is a small, pre-combustion chamber in the cylinder head. The small chamber contains the spark plug. A rich air/fuel mixture is supplied to this chamber by one carburetor through the third valve. A lean air/fuel mixture is supplied by the other carburetor to the normal chamber through the normal intakes (1). The rich mixture in the small chamber (2) provides good ignition, and the flame spreads to the lean mixture in the main chamber (3). Burning in the cylinder is slower and more efficient than in conventional engines and by prolonging the

STRATIFIED CHARGE SYSTEM



combustion most exhaust pollutants are burned up inside the cylinder. Test results suggest a gain, rather than loss, in fuel economy with this system.

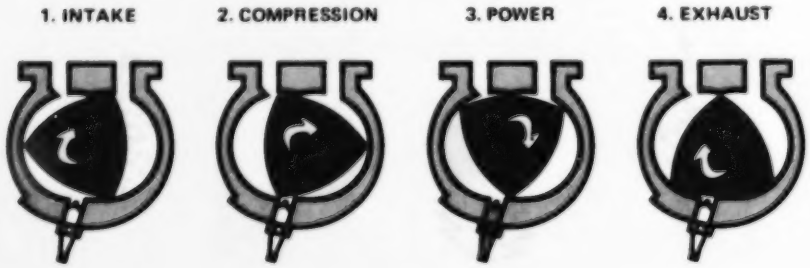
A National Academy of Sciences report says the stratified charge engine should be capable of meeting the 1976 standards, if used on small cars. Maintenance should be no greater than is required by 1973 conventional engines. Fuel economy should be comparable to 1972 engines and superior to a 1976 conventional engine equipped with the dual catalyst control system.

Wankel or rotary engine—Another Japanese manufacturer is using a totally different type of spark-ignited engine and emission control. This engine is known as the Wankel, or rotary. The emission control is called a thermal reactor. A compact car equipped with this system meets the emission standards for 1975.

The Wankel, or rotary, engine has no pistons or conventional valves. Instead, the engine block contains one or more rotors shaped like triangles. These rotate on an

WANKEL OR ROTARY ENGINE

In the Wankel, the intake, compression, power and exhaust functions take place almost simultaneously in only one turn of the three-lobed rotor.



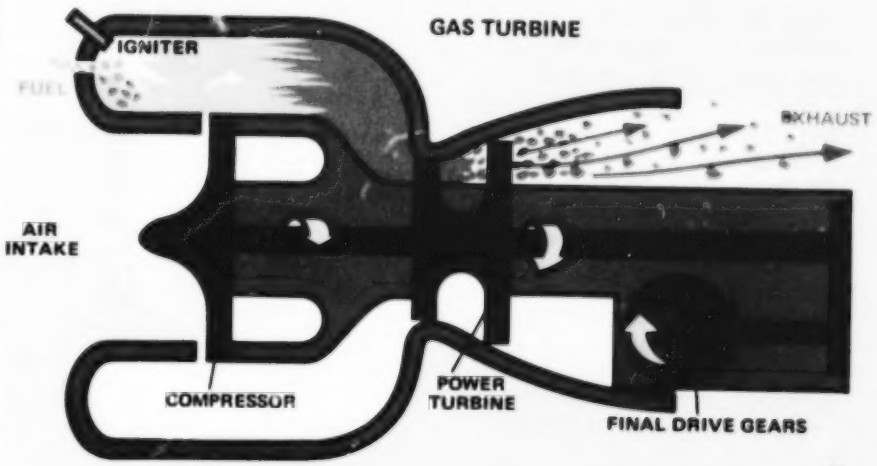
eccentric shaft in a rotor housing. Compression and combustion of fuel take place as the volume changes between the rotor and the housing.

A thermal reactor is a high-temperature chamber that replaces the conventional engine's exhaust manifold. In the Japanese firm's system, hot gases from the rotary engine enter the reactor where further burning of hydrocarbons and carbon monoxide occurs.

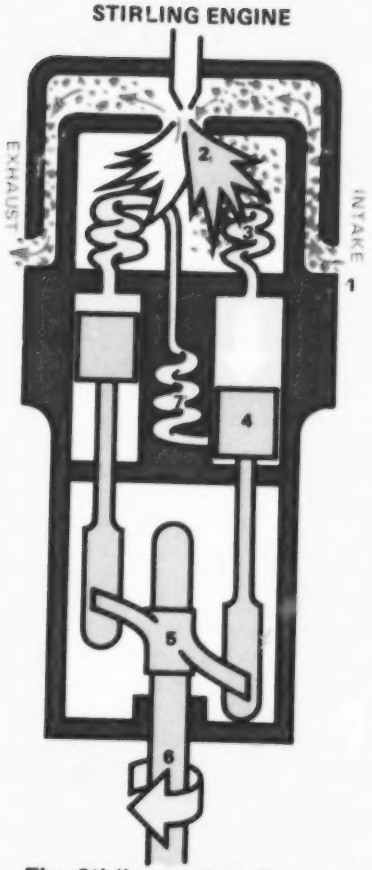
The Japanese-made car with this system does not yet meet the original stringent standards (90 percent reduction from uncontrolled cars) for emissions of nitrogen oxides, but durability tests suggest that the rotary with thermal reactor is superior to the dual-catalyst system. Compared to 1973 conventional engines, however, the rotary uses more fuel. A fuel penalty of 30 percent is predicted.

EPA is also working toward new engine types and the elimination of the inefficient internal combustion engine. Research is being conducted at the EPA facility in Ann Arbor, Michigan. Some of the cleaner alternatives to today's automotive engine are the gas turbine, the Rankine cycle engine, the Stirling, and the diesel.

The gas turbine is potentially reliable and quiet. It uses a single combustion chamber and combustion is continuous. Power is generated when heat expands gases from the combustor to drive a high-speed turbine. Power from the moving turbine is then transmitted through a set of gears to the car's transmission. An advantage of the turbine is that combustion can be adjusted for very efficient burning of the fuels and minimum pollutants in the exhaust. However, it has problems of high fuel consumption and low acceleration.



STIRLING ENGINE

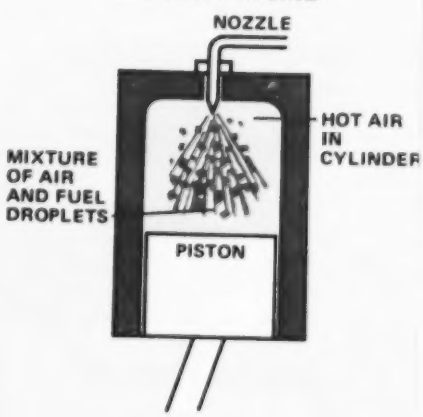


The Stirling engine—This is an external combustion heat engine. Fuel enters at the intake (1) and burns in the combustion chamber (2) which heats gas (hydrogen) in tubes (3). The heated gas expands and forces the piston (4) to turn a swashplate (5) that rotates the drive shaft (6). The gas moves into a cooling chamber (7), and the process is repeated. The engine has low hydrocarbon and carbon monoxide emissions but is a little high on nitrogen oxides. A prototype engine is reportedly heavy, complex and expensive.

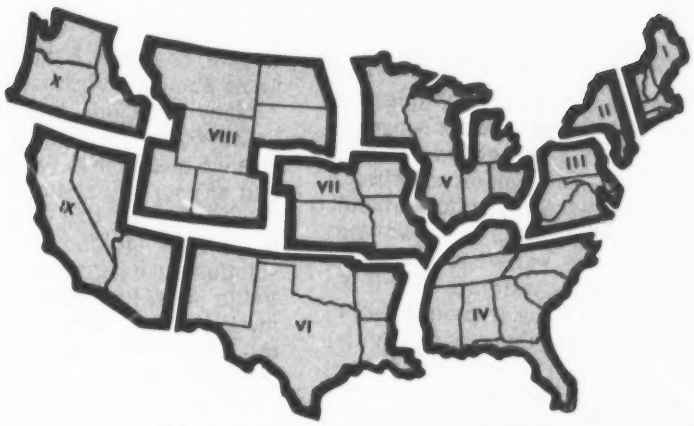
The Rankine cycle engine—In a Rankine cycle engine (steam engine), combustion takes place outside the engine. The hot exhaust gases heat a fluid such as water which then expands in either a turbine or a piston-type expander to create power.

The diesel engine—In the diesel process, only air is compressed in the cylinder, while fuel is injected late in the compression stroke and is ignited by the heat of compression. This engine has been tested successfully in EPA laboratories and meets Federal emission limits on carbon monoxide and hydrocarbons. It also obtains 75 percent better fuel economy than a conventional internal combustion engine of the same weight.

COMBUSTION PROCESS IN DIESEL ENGINE



Regional Organization



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Changes Are Necessary

By now you can see that we are facing some very real changes both in our automobiles and in our lives. Change, even when vitally necessary, is often difficult when it is thrust upon us without warning. We have been fortunate to have had a warning. Now it is up to each of us to prepare with intelligent forethought for the future.

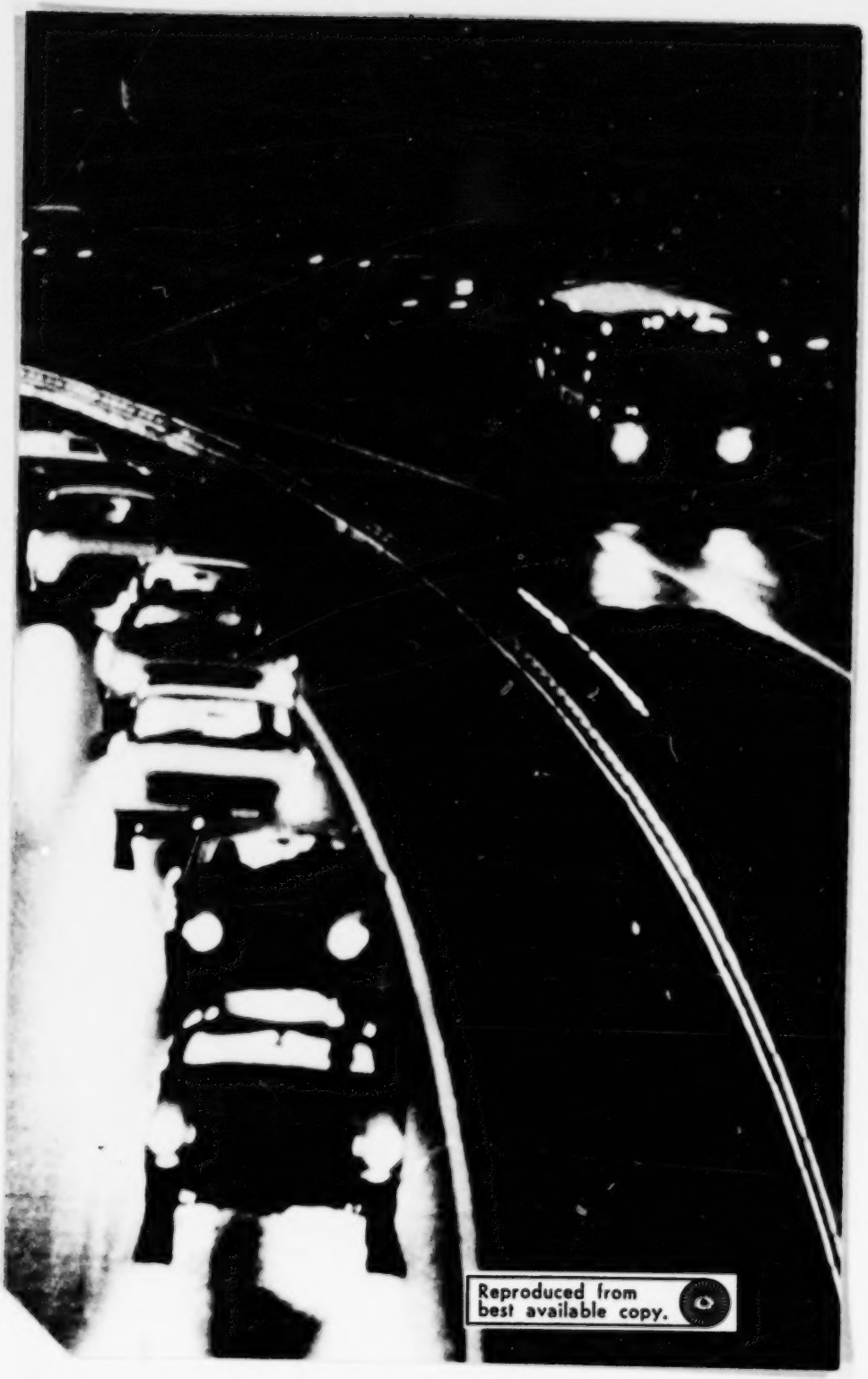
Hopefully, this booklet has informed you about the problems and the solutions that are evolving to meet them. But if we are to be successful, you, the American citizen, in whose name and for whose benefit these changes will be made, must lend your willing cooperation. Much will be done for you, but in the long run it will be your individual actions that will spell victory or defeat. You will ultimately decide whether we are to be winners or losers in this endeavor.

You can start deciding and acting now. Ask yourself some questions: Do you really need two cars? Does the comfort of a heavy car outweigh the economy of a lightweight automobile? Could you use mass transit more often? Or how about a car pool? Is your car tuned? What do you know about fuel economy?

Many questions need to be asked but the single most important question is found at the end of your key chain. Each time you sit behind the wheel ready to start the ignition, you hold the solution to exhaust emissions, traffic jams, fuel economy and the myriad other problems related to the automobile. Learn to ask yourself: "Is this trip really necessary?"

Your answer is important.

All photographs from EPA's Documerica collection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